US-PAT-NO: 5889561

DOCUMENT-IDENTIFIER: US 5889561 A
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TITLE: Method and apparatus for scaling a compressed video bitstream

DATE-ISSUED: March 30, 1999

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APPL-NO: 08/ 334282

DATE FILED: November 4, 1994

US-CL-CURRENT: 375/240.03, 375/240.2 , 375/240.23

ABSTRACT:

A method and apparatus for **scaling** the bitstream of a compressed video signal includes partial decoding hardware (38, 41) to permit excising of higher frequency **AC DCT coefficients** or re-quantizing quantized data with a coarser quantization factor. The scaling is performed on a block (macroblock) basis in

a manner which linearly scales the amount of compressed data per block. An analyzer (40) generates a profile of cumulative partially decompressed data over a video frame, and bitstream scaling (42) is performed in a manner which insures that a profile of the scaled signal substantially comports with the profile of the original data.

13 Claims, 9 Drawing figures

Exemplary Claim Number: 1

Number of Drawing Sheets: 5

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Abstract Text - ABTX (1):

A method and apparatus for **scaling** the bitstream of a compressed video signal includes partial decoding hardware (38, 41) to permit excising of higher frequency **AC DCT coefficients** or re-quantizing quantized data with a coarser quantization factor. The scaling is performed on a block (macroblock) basis in a manner which linearly scales the amount of compressed data per block. An analyzer (40) generates a profile of cumulative partially decompressed data over a video frame, and bitstream scaling (42) is performed in a manner which insures that a profile of the scaled signal substantially comports with the profile of the original data.

Brief Summary Text - BSTX (11):

The method and **scaling** apparatus of the present invention includes partial decoding hardware to permit excising of higher frequency **AC DCT coefficients** or re-quantizing quantized data with a coarser quantization factor. The scaling is performed on a block (macroblock) basis in a manner which linearly scales the amount of compressed data per block. An analyzer generates a profile of cumulative partially decompressed data over a video frame, and scaling is performed to insure that a profile of the scaled signal substantially comports with the profile of the original data.

Detailed Description Text - DETX (4):

After variable length decoding, the decoded codewords are coupled to an inverse quantizer 11, wherein signal components which were quantized in the compression process are de-quantized. The de-quantized components are re-quantized in a quantizer 12 under the **control of a rate** controller 16. The rate controller 16 is adjusted to produce coded signal having a bit stream scaled in conformance with the desired reduced rate. Scaling is accomplished in this instance by the rate controller providing quantization values to the quantizer 12 which produce a coarser quantization of respective codewords than the original compressor. The re-quantized codewords are variable length coded in a variable length encoder VLC 13, and reformatted in the multiplexer 14 with signal components which did not undergo re-quantization. The reformatted signal is applied to a rate buffer 15 which, in

general, converts a bursty signal to a constant rate signal. The rate buffer includes an occupancy monitor which provides a **control signal for controlling the rate** buffer to condition the quantizer 12 to provide a constant rate signal. A more detailed description of this circuitry is available in an article, REDUCTION OF THE BIT RATE OF COMPRESSED VIDEO WHILE IN ITS CODED FORM, by D. G. Morrison et al., PV'94, D17.3.

Detailed Description Text - DETX (17):

In one embodiment of the FIG. 4 apparatus, a rate controller 47 (shown in phantom) is employed to control re-quantization. In this embodiment, the analyzer applies **control parameters to the rate** controller on a frame basis and thereafter the **rate controller controls** the re-quantization process. The assumption is made that the rate controller is of the type which employs a frame target bit size to generate quantization factors for respective macroblocks. In such rate controllers, the frame target bit size may either be calculated by the rate controller itself or applied from an external source. An example of this type of rate controller is described in U.S. Pat. No. 5,144,424 entitled APPARATUS FOR VIDEO DATA QUANTIZATON CONTROL, by Tristan Savatier. The controller in this patent generates a parameter TSize.sub.-- i (the index i designates I, B or P frames) which is utilized in calculating respective quantization factors for frame i. For present purposes it is assumed

that such a rate controller will be modified to accept a target parameter TSize.sub.-- i from the analyzer 40.

Detailed Description Text - DETX (18):

The analyzer 40, in this instance, extracts the quantization factor Q.sub.MBi from respective coded macroblocks and counts the respective bits MB.sub.i for respective macroblocks in the data stream provided by the VLD 38. It forms the product Q.sub.MBi (.SIGMA.MB.sub.i) of the sum of bits times the quantization factor associated with the macroblock. Sums, .SIGMA.Q.sub.MBi (.SIGMA.MB.sub.i).sub.i, of the products generated for all previous macroblocks for a respective frame are formed for each macroblock and stored in the memory 46 identified by macroblock number; where .SIGMA.Q.sub.MBi (.SIGMA.MB.sub.i).sub.1 is equal to Q.sub.MB1 (.SIGMA.MB.sub.1); .SIGMA.Q.sub.MBi (.SIGMA.MB.sub.i).sub.2 is equal to Q.sub.MB1 (.SIGMA.MB.sub.1)+Q.sub.MB2 (.SIGMA.MB.sub.2) etc. These sums plotted against macroblock number form a normalized profile similar to the example illustrated in FIG. 3. Note however that this profile relates to total bits not only AC DCT bits because the rate controller operates on a total bit basis. A profile of AC DCT bits may also be used if the resulting target value is appropriately augmented for the non-quantized signal components. The final sum .SIGMA.Q.sub.MBi (.SIGMA.MB.sub.i).sub.last is scaled by the factor SF to generate the target value TSize.sub.-- i which is

applied to the rate
controller 47 for re-quantizing the current frame. The variable length decoded
signal is then accessed from delay memory 39, de-quantized, and re-quantized by
quantizer 43 under **control of the rate** controller 47 utilizing the calculated
value of TSize.sub.-- i . The profile is a normalized curve, but the rate
controller operates with a volume of bits, not normalized bits. Thus the scale
factor SF is in units of 1/Q.sub.MB to provide a target in units of bits. An
exemplary scale factor SF may be calculated according to the formula ##EQU1##
where (.SIGMA..SIGMA..sub.MBi).sub.last corresponds to the total bits in the
respective original frames and excess is the amount of bits in excess of the
target value for the previous frame. An alternative scale factor that may be
used is the ratio (1-%)/Q.sub.MBiavg, where Q.sub.MBiavg is the average of all
original quantizing factors in the frame.

Claims Text - CLTX (24):
forming a profile of accumulated data representing a linearly **scaled** profile
of said cumulative sums of **AC DCT coefficients**; and wherein said step of
quantizing includes: